Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
Mitigation Orbital Debris in the New Space Age	)	IB Docket No. 18-313
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COMMENTS OF TELESAT CANADA

Telesat Canada ("Telesat") submits these comments in response to the above-referenced Federal Communications Commission (the "Commission") Notice of Proposed Rulemaking (the "NPRM").[1] Telesat operates a global fleet of 17 geostationary earth orbit ("GSO") satellites and has been authorized by the Commission to serve the United States with Ka-band and V-band low earth orbit ("LEO") non-geostationary satellite orbit ("NGSO") satellites that will offer ultra-low latency, extremely high-throughput, affordable broadband services throughout the U.S. and the rest of the world. Telesat, therefore, is keenly interested in ensuring a balanced, sustainable operating environment for the New Space Age and applauds the Commission for initiating this proceeding at this critical and exciting juncture in commercial space operations.

Introduction

As the Commission recognizes in the NPRM, orbital debris mitigation guidelines must carefully balance the objective of mitigating orbital debris against the goal of maximizing space commerce investment and innovation. The complexity of developing and modifying orbital debris guidelines is further compounded by the fact that space is an international resource and even within the U.S. alone, there are a number of U.S. government agencies in addition to the Commission that may play a role and have expertise in the development and application of orbital debris mitigation guidelines and standards. Industry stakeholders are also actively engaged in developing industry best practices on orbital debris mitigation to ensure the

[1] *In the Matter of Mitigation of Orbital Debris in the New Space Age*, IB Docket No. 18-313 (rel. November 19, 2018)

sustainability of space operations. A flexible framework is therefore required that avoids duplication of effort and inconsistent regulation or standards, focuses on balanced performance-based guidelines rather than prescriptive measures, and draws on existing and developing agency and industry expertise and the evolving domestic and international landscape of stakeholder agencies and groups.

In the remainder of these comments, Telesat addresses the proposals in the NPRM in light of the over-arching principle of balance.

Control of Debris Released During Normal Operations and Minimizing Debris Generated by Release of Persistent Liquids

The Commission currently requires satellite operators to state that no debris will be released by a satellite during normal operations or, if this is not the case, examines plans for such release and has discretion to determine whether approval is in the public interest. Telesat supports this approach and believes that it should be extended to apply equally to the release of persistent liquids during or at the end of a mission.

The Commission also proposes to require satellite applicants to disclose and justify the use of deployment devices that detach from or are ejected from a launch vehicle upper stage and are designed solely as a means of deploying a satellite or satellites ("detachable deployment devices"), and to provide an orbital debris mitigation plan for such devices. While Telesat agrees that assessment of debris mitigation strategies is important at all phases of a satellite mission including launch, consideration of detachable deployment devices is a matter that is best left with the launch licensing authority. The launch operator and licensing agency rather than a satellite applicant will have control over and the requisite information to address the use and disposal of these devices. Indeed, the manner of satellite deployment may be unknown to a satellite applicant at the time authority to operate the satellite is sought from the Commission.

Safe Flight Profiles

The Commission has identified a number of areas for consideration in assessing safe flight profiles including collision risk, orbit selection, data tracking and sharing, maneuverability,

multi-satellite deployments and design reliability. The Commission's proposals on these issues are discussed below.

1. Quantifying Collision Risk

The *NASA Standards* identify the following collision risk metrics applicable to each spacecraft in or passing through LEO:

- a probability of less than 0.001 of accidental collision with space objects larger than 10 cm in diameter during orbital lifetime ("Large Object Collision Metric")[2]; and
- a probability of less than 0.01 of accidental collision with orbital debris and meteoroids sufficient to prevent compliance with applicable post-mission disposal requirements during the mission.[3]

Telesat supports application of these NASA metrics to NGSO satellites, but suggests that the metrics should be pro-rated based on a 5 year service life (which was the expected LEO satellite mission life when the standards were developed).[4] This will avoid encouraging shorter and less efficient missions. A perpetual NGSO constellation using satellites with a mission life of 5 years would satisfy these standards but deploy replacement satellites every 5 years, increasing with each deployment of replacement satellites the risk of debris. It is more efficient and better for the space environment to incent longer mission lives by applying pro-rated metrics which effectively achieve the same level of debris protection. Consistent with the NASA specification, these collision risk metrics should also be assessed on a per spacecraft basis. Application of these metrics on an aggregate or system-wide basis would artificially cap constellation size and hamstring the ability of LEOs to provide continuous high capacity global coverage.

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[2] NASA-STD-8719.14, Process for Limiting Orbital Debris, available at https://standards.nasa.gov/standard/nasa/nasa-std-871914 (*NASA Standards*), 4.5.2.1, page 32. The *NASA Standards* also define a large object as an object with a diameter of 10 cm or more. Going forward, Telesat suggests that consideration be given to defining "large objects" as those objects that are detected and tracked and can be effectively avoided. At present, the minimum size of such objects is about 10 cm, but this size may change over time.

[3] *NASA Standards*, 4.5.2.2, page 32.

[4] *NASA Standards*, 4.6.3, page 38. Under a pro-rated approach, a satellite with a service life of 5 years would be required to satisfy the metrics as specified. The risk cap would be doubled for a satellite with a service life of 10 years or, conversely, halved for a satellite with a service life of 2.5 years.

Also, if the spacecraft has collision avoidance capability and the applicant demonstrates a commitment and ability to conduct active collision avoidance, the risk of collision with large objects should be considered to be zero during the period of time that the collision avoidance capability is functional for purposes of applying the Large Object Collision Metric.[5] Thus the cumulative risk of collision with a large object assessed over all periods of orbital life that the spacecraft cannot perform collision avoidance maneuvers (e.g., for a spacecraft with collision avoidance capability that is exercised, at the beginning of life before collision avoidance capability has been commissioned, during service life when there are contingencies, and after passivation) must satisfy the Large Object Collision Metric. This approach to application of the Large Object Collision Metric provides an incentive to spacecraft operators to minimize the periods during which the spacecraft cannot perform collision avoidance maneuvers (including minimization of the longest such period which is the period after passivation).

In addition to the NASA collision risk standards, Telesat believes that spacecraft in orbits above 400 km should be designed to be capable of performing timely and effective collision avoidance maneuvers sufficient to reduce the probability of collision per conjunction for the spacecraft to less than 0.0001 from the time that the spacecraft becomes operational until the spacecraft fails or is passivated.

2. Orbit Selection

The risk of collision with other spacecraft deployed above the ISS is best addressed by requiring these spacecraft to have collision avoidance capability and by operators using this capability to mitigate the risk of collision with other spacecraft and large debris. However, the specific means of avoidance capability (i.e., propulsion capability) should not be mandated. This will provide operators with the flexibility to implement innovative and cost-effective means of conducting collision avoidance provided they can demonstrate that the probability of collision per conjunction is less than 0.0001.

[5] At NPRM, para. 26 the Commission states "if a spacecraft's orbital debris mitigation plan includes maneuvering to avoid collisions, we should, consistent with current licensing practice, consider this risk to be zero or near zero during the period of time in which the spacecraft is maneuverable, absent contrary information". In addition to maneuverability, the spacecraft operator should certify that collision avoidance will be performed.

With regards to operations in higher debris regions, an applicant seeking authorization to operate in such a region will necessarily need to account for this debris in demonstrating compliance with the collision risk metrics and, as a result, additional restrictions on operating in more populated areas of space are unnecessary.

Finally, data sharing between operators coupled with collision avoidance address the risk of collision between spacecraft in overlapping orbits. Typically, it is sufficient for operators to rely on the Air Force's 18th Space Control Squadron conjunction assessments (or assessments from such other civilian entity as may be tasked with this function) to identify when there is a risk of collision between spacecraft and take appropriate action to mitigate the risk of collision, but if constellations operate in overlapping orbits, closer data sharing and physical coordination is required. Thus a satellite applicant should be required to identify other spacecraft operating or authorized to operate in overlapping orbits and the applicant's plans for sharing data with the operators of these spacecraft and addressing potential conjunctions (through coordinated maneuvers) with these spacecraft. These measures allow for maximum use of orbital resources, whereas a maximum limit on variances in orbit altitude above or below the operational orbit identified in an application for an NGSO system might arbitrarily and unnecessarily bar use of valuable orbital real estate.

3. Tracking and Data Sharing

Spacecraft should be designed to be reliably trackable from the ground using passive (e.g. radar, optical or passive RF) tracking means and spacecraft with limited visibility should include enhanced visibility.

With regards to data sharing, the Commission proposes in the NPRM to adopt an operational rule requiring NGSO satellite operators to provide certain information to the Air Force's 18th Space Control Squadron or any successor civilian agency including information on initial deployment, ephemeris, and any planned maneuvers. The Commission also proposes to require applicants for NGSO systems to certify that upon receipt of a conjunction warning, the satellite operator will assess and, if necessary, take all possible steps to mitigate the risk of collision including, but not limited to, contacting the operator of any active spacecraft involved in the warning, sharing ephemeris data and other appropriate operational information with any

such operator and modification of spacecraft altitude and/or operations. Telesat supports the obligation to share information on initial deployment, ephemeris and planned maneuvers with the Air Force's 18th Space Control Squadron or a successor agency. Telesat also supports certification by a satellite applicant that it will assess all conjunction warnings on receipt and take steps, as necessary, to mitigate the risk of collision, but concurs with the SIA proposal that the certification should confirm the taking of "*appropriate* steps" and the specifically enumerated steps that will be taken (e.g., contacting the other satellite operator and sharing ephemeris data, maneuver plans and other appropriate operational data, and performing a coordinated, effective maneuver if necessary) should be limited to a conjunction involving active satellites that warrants mitigation due to proximity of the satellites.

4. Maneuverability

The FCC proposes that applicants for NGSO satellite authorizations describe the extent of any maneuver capability including, for example, the number of collision avoidance maneuvers the satellite could be expected to make and/or other means of avoiding conjunction events, and maneuverability of the satellite(s) during orbital lifetime. The Commission does not propose to require all satellites to have propulsion or maneuverability.

Telesat supports the proposed disclosures which will inform the assessment of collision avoidance capability. As discussed above, Telesat believes that NGSO spacecraft in orbits above 400 km should be designed to be capable of performing timely and effective collision avoidance to reduce the probability of collision per predicted conjunction to less than 0.0001, but the means of achieving this capability (such as propulsion) should not be mandated.

5. Multi-Satellite Deployments

A space station applicant has no control over and, as the NPRM notes, may have no knowledge of, co-passengers on the launch vehicle when a request for authorization is submitted to the Commission or even at the time of launch. Therefore, Telesat recommends that matters related to launch vehicles, including multi-satellite deployment vehicles, be left to the consideration of the launch licensing agency.

6. Design Reliability

Mitigation of debris due to NGSO spacecraft failure is best addressed through the application of appropriate safeguards to mitigate the risk of dead-on-arrival satellites and through post-mission disposal reliability. Specifically, the risk of dead-on-arrival spacecraft can be addressed by requiring that the spacecraft be launched into orbit with a deorbit life of less than 25 years or into a seldom-used orbit, or alternatively that the spacecraft undergo rigorous ground-based environmental acceptance or protoflight testing based on established test standards and procedures (as is currently done for GSO spacecraft). These balanced and targeted safeguards (coupled with the post-mission disposal guidelines discussed below) appropriately address the risk of debris due to satellite failure.

Post-Mission Disposal

1. Probability of Success of Disposal Method

In the NPRM, the Commission proposes to require applicants to provide information regarding the expected reliability of disposal involving atmospheric re-entry and the method by which the expected reliability was derived, and to require disposal of LEO spacecraft through re-entry or direct retrieval. Telesat concurs with these proposals. Although direct retrieval is not feasible at this time, it may be in the future. De-orbit servicing capability (which could be used to lower an object to an orbit where it will decay passively to re-entry) is also being developed. Spacecraft operators have commercial incentives to consider including technologies and features that may facilitate capture and deorbit and to retain information on the spacecraft. It would be premature, however, to mandate specific design features at this juncture, given the nascent status of servicing and retrieval technologies.

The Commission also asks whether it should impose a minimum probability of success of disposal of 0.90 consistent with the *NASA Standards*[6], or if it should consider a higher metric and/or should assess the probability of success on an aggregate or system-wide basis. The NASA standard of 0.90 probability of success of disposal of a satellite is currently an appropriate benchmark. While satellite operators should strive to satisfy a higher stretch target of 0.95

[6] *NASA Standards*, 4.6.2.4, page 38.

disposal reliability per satellite, mandatory compliance with this standard would be premature. Furthermore, the application of a disposal reliability standard on a system-wide basis is expected to make it impossible to deploy innovative new LEO constellations supporting global coverage.

In addition, the NPRM asks whether applicants seeking authorization to operate satellites in LEO at 650 km or above should be required to certify that the satellites will be initially deployed into an altitude below 650 km and/or that the satellites will initiate automatic disposal on loss of power or contact. Launch into low orbit is only one means of reducing the risk of dead-on-arrival spacecraft. As discussed above, alternative means such as rigorous environmental acceptance testing should also be permitted. A requirement to operate some number of satellites in low orbit for some period of time would seriously if not critically undermine the business case for new constellations and conflict with existing milestone and bond requirements, and should not be implemented. Moreover, while autonomous passivation might be workable, autonomous deorbit risks increasing collisions and orbital debris due to unpredictable thruster operation, and should not be mandated.

With regards to disposal of spacecraft operating above LEO, permission to dispose of the spacecraft in a little-used orbit and case-by-case assessment of deorbit plans that transit LEO or GSO regions remains appropriate. As the Commission notes in the NPRM, there is a risk of collision between LEO satellites and higher velocity satellites moving through LEO during disposal. The movements of these deorbiting satellites are unpredictable and there is insufficient prior notice for a satellite operator to predict conjunctions with operational spacecraft and conduct collision avoidance maneuvers. Thus where re-entry through deorbit is being used as the disposal mechanism, careful scrutiny is required to ensure that the spacecraft complies with the Large Object Collision Metric.

2. Post-Mission Lifetime

The 25-year guideline on post-mission lifetime should be reviewed periodically to determine if it remains adequate in light of prevailing conditions and technologies. At present, there is no apparent reason to change the guideline, but it may be in the public interest to do so in the future. Operators of spacecraft using propulsion to deorbit should also strive to complete the deorbit phase within 5 years of end of mission.

3. Casualty Risk Assessment

The Commission identifies two casualty risk assessment requirements for satellites with planned post-mission disposal through atmospheric re-entry: (1) the risk assessment should include all objects that could have an impacting kinetic energy in excess of 15 joules; (2) if the calculated human casualty risk is greater than zero using the NASA Debris Assessment Software or higher fidelity model, a statement should be provided indicating the actual calculated risks and input assumptions to the model. Telesat concurs with these requirements and with application of the NASA standard for the risk of human casualty of 1:10,000 per spacecraft.[7] The application of this standard on a per spacecraft basis ensures greater protection of life and property than is the case for aircraft, regardless of constellation size. An aggregate or system-wide metric is therefore unnecessary and risks prohibiting new NGSO constellations.

4. Part 25 GSO Satellite License Term Extensions

While the Commission proposes to continue to assess requests for GSO license extensions on a case-by-case basis, the NPRM proposes that a single license extension be capped at no more than 5 years for a GSO satellite initially licensed for a 15 year term. Telesat believes that a five-year cap would unnecessarily restrict the Commission's flexibility to approve longer license extensions where consistent with the estimated remaining satellite lifetime. The current case-by-case approach to license extensions provides the Commission with discretion to determine an appropriate extension term, which may be shorter or longer than 5 years. This flexible approach minimizes regulatory proceedings and costs for the Commission and licensees.

The Commission also asks whether it should codify certain information requirements and certifications for license extension modification requests. The existing practice is flexible and functions well. Should, however, the Commission determine that there is a benefit to codification of its current practice, it is critical that codification expressly provide for the ability to submit a narrative explanation in lieu of a mandatory certification.

[7] *NASA Standards*, 4.7.2.1, page 44.

Proximity Operations

Telesat suggests that issues related to servicer operators and operations be addressed by the agency responsible for licensing such missions, based on specific information relating to capabilities and proposed operations.

Operational Rules

1. Orbit Raising

The Commission proposes to extend its rule permitting GSO telemetry, tracking and command ("TT&C") on a no protection, no interference basis during orbit raising to cover NGSO operations as well. In addition, the Commission proposes to require that these TT&C operations be coordinated as necessary to avoid interference events, rather than requiring that they be conducted on a no interference, no protection basis. Telesat supports these proposals, which are consistent with Telesat's view that orbit raising and orbit lowering should generally be treated in the same manner as normal satellite operations. Accordingly, when orbit raising or orbit lowering may cause harmful interference to other operational satellites, coordination should be required. Moreover a satellite engaged in orbit raising or orbit lowering outside its authorized orbital parameters should have no coordination priority. Thus, for example, a satellite licensed to operate in GSO would not have priority for purposes of coordinating orbit raising activities with other authorized satellites.

2. Maintaining Ephemeris Data

The Commission has previously adopted a rule requiring all NGSO licensees and market access recipients to ensure that ephemeris data for their constellations are available to all operators of authorized, in-orbit, co-frequency systems. The Commission proposes to extend this rule to require NGSO operators to maintain ephemeris data for each satellite they operate and share that data with operators of other systems in the same region of space as well as with the U.S. governmental agency responsible for the civilian space object database. The information would be shared by means mutually acceptable to the parties involved. Telesat concurs with these proposals.

3. Telemetry, Tracking and Command Encryption

The Commission proposes in the NPRM a new rule requiring encryption of telemetry, tracking and command communications for satellites with propulsion capabilities.

As the Commission notes, most commercial operators currently encrypt command frequencies. A rule requiring encryption of command frequencies is therefore not necessary for commercial operators.

Telesat does not believe that there should be a requirement to encrypt telemetry and tracking communications either. This would impose additional costs on satellite operators, with no countervailing benefit.

Liability Issues and Economic Incentives

The NPRM seeks comment on whether the Commission should require space station licensees to indemnify the U.S. against any costs associated with a claim brought against the U.S. related to authorized facilities through, for example, an indemnification agreement with the U.S. Department of State, as well as on the potential costs and benefits of mandatory insurance or a performance bond to be released on successful completion of end of life disposal. The Commission lacks a demonstrable jurisdictional basis for imposing an indemnification requirement. Moreover, the guidelines discussed above provide a comprehensive framework for mitigating orbital debris. Indemnification, insurance and bond requirements will add material costs to satellite operations without advancing orbital debris mitigation in any specific way other than by potentially undermining the business case for some New Space commercial operations.

Scope of Rules

1. Amateur and Experimental Operations

Telesat believes that amateur and experimental operations should be subject to the same space sustainability rules and guidelines as commercial operations.

2. Non-U.S.-Licensed Satellites

Telesat is both a U.S.-licensed satellite operator and an operator of foreign-licensed satellites that have been granted access to the U.S. market. In general, Telesat supports application of consistent space sustainability rules and guidelines to both U.S.-licensed spacecraft and spacecraft that are granted access to the U.S. market. However, on issues of economic liability, the Commission should defer to the national licensing agency or other agency that has committed to registering the satellite with the United Nations as a space object.

Conclusion

The Commission should strive for a careful balance between mitigation of growth in orbital debris and maximization of space commerce investment and innovation. The Commission can achieve this objective by employing flexible orbital debris guidelines along the lines identified in these comments that draw on and fit within the evolving activities and expertise of other government, international and industry stakeholder groups on this critical issue.

Respectfully submitted,

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